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SOME CHARACTERISTICS OF A SHELTER BELT AT THE GLASSHOUSE INVESTIGATION UNIT, AUCHINCRUIVE, AYRSHIRE

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INTRODUCTION

A shelter belt of ICI 'Parawebs' was constructed at the GIU, Auchincruive during the summer of 1975. It was positioned to protect the glasshouses from winds between S and SW, as some of the strongest winds at this location occur in that sector. An experiment was set up to find out how effective the shelter belt proved to be in reducing wind speed and thus saving on heat loss from the glasshouses and also on structural damage due to high winds.

SITING OF ANEMOMETERS

The shelter belt is 10 ft (~3.1 m) high and is 13.7 m from the nearest glasshouse which has a ridge height of 15 ft 6 in (~4.7 m). The anemometers inside the shelter were placed approximately three "heights" behind the wind break while the two instruments outside the belt were placed in an open position 26 m from the shelter belt. During the 19 October 1976 two anemometers (D and F) were resited at the eastern end of the belt (Fig 1a and 1b). The two cup counter anemometers sited outside the shelter were at heights of 1.8 m (A) and 3 m (B) above the ground. The other two cup counter anemometers were E and F which were at heights of 1.8 m and 3 m approx. C and D were cup contact anemometers, C was approx 3 m above ground level and D approx 1.8 m.

DATA ACQUISITION

The staff at GIU Auchincruive read the run of wind from the four cup counter anemometers each day at 0900 GMT and changed the charts each week for the two cup contact anemometers. Throughout the period 7 June 1976 to 30 April 1977 readings of run of wind were obtained at 3 m and 1.8 m from outside the shelter belt and at 1.8 m inside the shelter belt. Readings of run of wind were obtained at a height of 3 m inside the shelter belt from 7 June 1976 to 19 October 1976 and at the Eastern end from 20 October 1976 to 30 April 1977. The main wind direction for each day was taken from the hourly wind tabulations at Prestwick Airport which lies approx 2 miles NNE of the site at Auchincruive.

Unfortunately the cup contact anemometers did not provide satisfactory results. There was a problem with corrosion of wiring and with the 6 volt batteries and most of the results were either highly suspect or no trace was obtained due to lack of current. This left only the results from the cup counter anemometers to be analysed.

FH2B

RESULTS

Winds from between SE and SW were considered for the inside/outside comparisons as these directions are more or less normal to the barrier. The same directions were considered for the end/outside comparison and then from the SE only to test the edge effect of the shelter belt. For each day there were four readings and the ratio of inside/outside run of wind was calculated for a height of 3 m and 1.8 m above ground; after 19 October 1976 the inside/outside ratio at 3 m being replaced by end/outside at that height.

The run of wind obtained at a height of 3 m in the open was used to define the range of wind speed and each ratio was allocated to the appropriate wind speed range. A mean value of the ratio for each wind speed range was then calculated. The results are summarised in Table I.

At a height of 3 m there was no significant difference in the mean value of the ratios with increased wind speed range. The decrease in wind was about 35%. At a height of 1.8 m the reduction in wind speed within the shelter break was 48% with light winds, 57% in the middle range and 62% with wind speeds of 300 miles/day or greater. A 't' test was applied to the mean values in Table I to test the significance of these differences and there was found to be a significant difference between the mean value for light winds and that for winds over 300 miles/day but not between the mean value for the range 200-299.9 miles/day and that for over 300 miles/day.

For each range of wind speed the winds were reduced by a greater amount at a height of 1.8 m than at 3 m. In the range 0 to 199.9 miles/day the decrease in wind speed was 48% at a height of 1.8 m and 36% at a height of 3 m and in the range 200 to 299.9 miles/day the decreases were 57% and 35% respectively. A 't' test was again applied to the mean values in Table I, this time to test the significance of the differences in mean value with height and with each range of wind speed the decrease at 1.8 m was found to be significantly greater than the decrease at 3 m above ground.

Still considering the winds in the sector SE to SW there was found to be a reduction of 19% to 31% in wind speed at a height of 3 m at the eastern end of the windbreak. Further 't' tests were applied to the results in Table I. Firstly to assess the significance of the difference in mean values with increased speed at the end of the shelter belt - there was found to be a significant decrease with increased speed. Secondly to compare the difference in mean values at a height of 3 m inside the windbreak and at the edge of the wind break. Each range of wind speeds was considered separately and in each case the decrease in wind speed at the edge of the belt was significantly less than inside the belt. Winds from the SE were then considered separately to discover the effect at the eastern end of the shelter belt of winds from that direction. A reduction of 10 to 13% was found but no significant difference in mean value with increased wind speed.

In a few cases the run of wind at the end of the barrier was higher than that outside in the open. In all cases but one this occurred with winds less than 200 miles/day and it was probably caused by local eddies around the edge of the shelter belt. The maximum increase was 10% and the average increase was 4%.

EFFECTIVENESS OF SHELTER

From the above results it is apparent that the shelter belt causes a considerable decrease in wind strength with winds from between SW and SE. This results in savings in heat loss from the glasshouses and consequent savings in heating costs. It also results in the prevention of structural damage to the glasshouses.

RESUME OF MAIN POINTS

(i) High wind speeds are reduced by a greater amount than low wind speeds.

(ii) Greater reduction in wind speed at 1.8 m than at 3m, the height of the windbreak..

(iii) Minor 'edge' effects noted.

From the above conclusions the shelter belt is seen to be most effective with strongest winds. As strong winds are the dominant factor in heat loss from glasshouses (Sims 1974) this is a satisfactory result. The greatest reduction for a given wind speed in the open is at below the height of the top of the shelter belt, therefore it will be worth considering the effect at the ridge height of the glasshouses to find out if there is still an effective reduction at that height. All the anemometers were sited at 3 x "height" of barrier behind the shelter therefore it will be worth considering other distances behind the barrier.

REFERENCE

Sims F P (1974) - Wind and temperature in relation to the loss of heat from glasshouses. Ag Memo No. 614.

Any comments or suggestions on this paper should be referred to the author.

Meteorological Office
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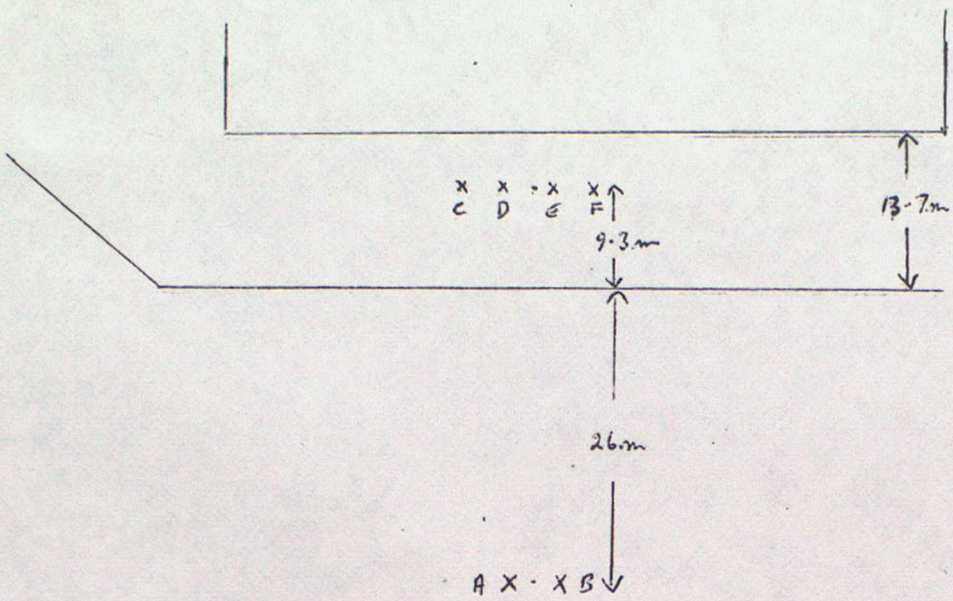
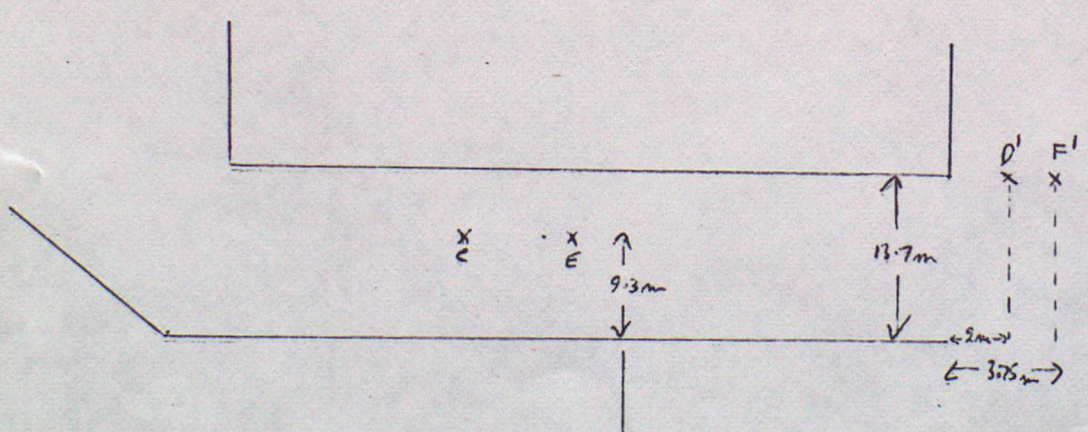
FIGURE I

A Cup counter ~ 1·8m
B " " 3·0m
C Cup contact 2·8m
D " " 1·6m
E Cup counter 1·8m
F " " 3·2m



APPROX NORTH ↑

(a) POSITION OF ANEMOMETERS
FROM 7th JUNE to 19th OCTOBER 1976.



A, B, C } as in (a)
D' Cup contact ~ 1·8m
E as in (a)
F' Cup counter ~ 2·9m

(b) POSITION OF ANEMOMETERS
FROM 19th OCTOBER 1976
to 30th APRIL 1977

TABLE I

RATIOS CONSIDERED (SE TO SW EXCEPT WHERE STATED SE ONLY)		RANGE OF WIND SPEED mils/day (3m OUTSIDE ANEMO AS STANDARD).		
		0–199.9	200–299.9	300+
INSIDE 3m / OUTSIDE	MEAN	.64	.65	
	No. OF OCCASIONS	26	9	
INSIDE 1.8m / OUTSIDE	MEAN	.52	.43	.38
	No. OF OCCASIONS	82	38	20
END 3m / OUTSIDE	MEAN	.81	.78	.69
	No. OF OCCASIONS	56	29	20
END 3m / OUTSIDE (SE only)	MEAN.	.87	.90	
	No. OF OCCASIONS.	29	8	